
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Oral Oncology 105 (2020) 104741

Contents lists available at ScienceDirect

Oral Oncology

journal homepage: www.elsevier.com/locate/oraloncology

Review

# What dentists need to know about COVID-19

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ARTICLE INFO

*Keywords:*
COVID-19
Epidemiology
Dentistry
Infection control

ABSTRACT

This article aims at collecting all information needed for dentists regarding the COVID-19 pandemic throughout the world by reviewing articles published by now. In late 2019, a pneumonia outbreak of uncertain etiology happened in Wuhan, China. There were many reports related to a live-animal and seafood market, supporting that the pathogens were transferred from animals to humans, rapidly evolving into transmission from human to human. The pathogen was classified as 2019 Novel Corona Virus (2019-nCoV), and the disease was named COrona VIrus Disease 2019 (COVID-19). Given that COVID-19 has lately been detected in infected patients' saliva, the COVID-19 outbreak is an alert that all dental and other health professionals must be vigilant in defending against the infectious disease spread, and it may enable to assess whether non-invasive saliva diagnostic for COVID-19. There has so far been no evidence from randomized controlled trials to prescribe any particular anti-nCoV treatment or vaccine, and COVID-19 management has been widely supportive. Since the ACE-2 was expressing on oral cavity mucosa, there is a potentially huge COVID-19 infectious vulnerability risk for oral cavity and brought up a proof for the future prevention procedure in dental practice and daily life. As a result, the whole dental teams should be vigilant and keep patients and themselves in a safe environment by following the guideline in this study.

## Introduction

In late 2019, a pneumonia outbreak of uncertain etiology happened in Wuhan, China. There were many reports related to a live-animal and seafood market, supporting that the pathogens were transferred from animals to humans, rapidly evolving into transmission from human to human. The pathogen was classified as 2019 Novel Corona Virus (2019-nCoV), and the disease was named COrona VIrus Disease 2019 (COVID-19) [1].

As of March 30, 2020, according to the World Health Organization (WHO), 2019-nCoV has involved 201 countries among which the most infected countries are shown in Table 1 [2]. This virus resulted in a mortality rate of 2% [3] and reproduction number ($R_0$) of 1.4–5.5 [4].

Coronaviruses belong to the Coronaviridae family including large, single, plus-stranded RNA as the genome [5,6]. Coronaviruses are divided into four groups: alphacoronavirus, betacoronavirus, gammacoronavirus, and deltacoronavirus [7]. The alphacoronavirus and betacoronavirus primarily infect the respiratory, gastrointestinal, and central nervous function of humans and mammals, while gammacoronavirus and deltacoronavirus mostly target the birds [5,8–10].

2019-nCoV is also a part of the betacoronavirus by the phylogenetic study based on the viral genome [11,12]. 2019-nCoV can attach to the human angiotensin-converting enzyme 2 (ACE-2), which is the same entry receptor for SARS-CoV. 2019-nCoV can also attach to the ACE-2 receptor from human, bat, pig and civet cat, cells, but it cannot attach to any cells in the absence of ACE-2 [12,13]. The strong association between ACE-2 and 2019-nCoV S protein indicated that the population having more expression of ACE-2 could be more prone to 2019-nCoV. [13].

## Clinical presentations

Most COVID-19 patients are fairly mild cases. Based on the latest studies from the National Health Commission of China, the proportion of serious cases among the whole COVID-19 patients in China ranged from about 15% to 25% [14].

The common clinical symptoms of the patients suffering from COVID-19 are fever, cough, shortness of breath, myalgia (muscle pain), tiredness, and abnormal chest CT, and the less usual symptoms are headache, production of sputum, hemoptysis, stomach pain, dizziness, nausea, diarrhea, and vomiting. Some ENT (Ear, Nose, and Throat) doctors now believe that a distortion of the sense of taste (dysgeusia) and smell blindness (anosmia) could be considered as COVID-19 symptoms. Disease onset can cause progressive respiratory failure

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https://doi.org/10.1016/j.oraloncology.2020.104741
Received 19 April 2020; Received in revised form 21 April 2020; Accepted 22 April 2020
Available online 28 April 2020

**Table 1**
Confirmed cases of COVID-19 statistics as of March 30, 2020.

| Country | Total cases | Total deaths |
|---|---|---|
| World | 693,282 | 33,106 |
| USA | 122,653 | 2,112 |
| Italy | 97,689 | 10,781 |
| China | 82,447 | 3,310 |
| Spain | 78,797 | 6,528 |

because of alveolar impairment and even death. [13,15–17] Older age and the presence of underlying comorbidities such as hypertension, diabetes, cardiovascular and cerebrovascular disease are commonly correlated with worse prognosis [18]. This new virus is also more probable to result in serious respiratory diseases in older males [19].

Besides, most patients' chest CT demonstrated bilateral pneumonia with ground-glass opacity (GGO) and bilateral patchy shadows as the most typical patterns [20].

## COVID-19 transmission

According to results from genetic and epidemiologic studies, the COVID-19 outbreak began with a single transmission from animal to human and then followed by ongoing human-to-human spread [1,21].

The typical transmission pathways of COVID-19 contain direct transmissions such as sneeze, cough, and inhalation of small airborne particles and contact transmission, i.e. contact with the oral, eye, and nasal mucous membranes. Although typical clinical presentations of COVID-19 do not contain eye symptoms, the examination of conjunctival samples from confirmed and suspected COVID-19 cases supports that the transmission of COVID-19 is not restricted to the respiratory tract, and that eye exposure may be a potential way for the virus to penetrate. COVID-19 can also be transmitted by saliva directly or indirectly [22-25].

While symptomatic COVID-19 patients are the primary transmission source, the latest findings indicate that asymptomatic patients and patients in the incubation period are also carriers of 2019-nCoV. Furthermore, it remains to be established that patients are a possible source of transmission during the recovery process [26].

Studies have indicated 2019-nCoV may be airborne by aerosols produced during medical treatments [27]. Within a fairly closed area, aerosol transmission is a potential transmission route when there is exposure to high aerosol concentrations. Regular dental treatments produce aerosols providing possible hazards for the dental staff and patients [1]. The droplet source can be nasopharyngeal or oropharyngeal, which is usually associated with saliva. Larger droplets may lead to viral transmission to nearby subjects, whereas smaller droplets contaminated with air-suspended viral particles may provide the long-distance transmission [28].

As a result, dental teams should be vigilant and keep patients and themselves in a safe environment.

## Incubation period

The average incubation period for COVID-19 has been projected to be 5 to 6 days, although there is evidence that it can last as long as 14 days, which is now the widely accepted length for medical monitoring and quarantine of potentially exposed individuals [14].

## The impact of temperature and humidity on COVID-19

High relative humidity and high temperature considerably decrease the COVID-19 transmission. Relative humidity rise of one percent and temperature rise of one degree Celsius reduce the effective reproductive number. This effect is the same as influenza. It suggests that the advent of summer and rainy season in the northern hemisphere will drastically decrease the COVID-19 transmission. [29]

## Diagnosis

The COVID-19 diagnosis can be according to a combination of epidemiological details (i.e., a travel history to or residency in an infected area two weeks before the onset of symptoms), laboratory tests, clinical symptoms, and CT imaging results. The outcome of a single negative test does not mean a suspected patient is not infected. We should clinically take into consideration the patients' epidemiological history, symptoms related to COVID-19, and positive CT results [14].

Given that COVID-19 has lately been detected in infected patients' saliva [24], the COVID-19 outbreak is an alert that all dental/oral and other health professionals must invariably be vigilant in defending against the infectious disease spread, and it may enable to assess whether non-invasive saliva diagnostic for COVID-19 may help diagnose and minimize the spread of such viruses. Theoretically, COVID-19 diagnosis may be achieved by salivary diagnostic platforms. Some virus strains have been identified in saliva even until 29 days after infection [30,31], suggesting that a non-invasive platform to swiftly differentiate the biomarkers using saliva may increase the detection of the disease [32]. Samples of saliva may be obtained as a symptom in patients having oropharyngeal secretions. Given the need for close contact between healthcare personnel and infected patients to obtain nasopharyngeal or oropharyngeal samples, the possibility of a saliva self-collection will significantly decrease the chance of COVID-19 transmission. In addition, the collection of nasopharyngeal and oropharyngeal is not comfortable and may cause bleeding particularly in patients with thrombocytopenia. Just 28 percent of COVID-19 patients produced the sputum of a lower respiratory tract, suggesting a significant limitation as a specimen for diagnostic assessment [24,33].

There are at least three different pathways for 2019-nCoV existence in saliva as follows [33]:

1- 2019-nCoV in the lower and upper respiratory tract entering the oral cavity along with the liquid droplets regularly exchanged by these organs
2- 2019-nCoV in the blood entering the mouth through crevicular fluid
3- Infection of the major and minor salivary glands with subsequent release of particles into saliva through salivary ducts

It is necessary to note that salivary gland epithelial cells may be affected with SARS-CoV shortly after infection in rhesus macaque, indicating that salivary gland cells can be a key source for this virus in saliva [33].

Furthermore, the development of SARS-CoV-specific Secretory Immunoglobulin A (SIgA) in the animal models' saliva has been previously demonstrated [34]. Taking into account the similarities of both strains, the salivary diagnosis of COVID-19 may also be achieved by using specific antibodies against the virus. As a result, saliva can play a crucial role in the transmission from humans to humans, and salivary diagnostics can create a simple and cost-effective point-of-care platform for infection with 2019-nCoV [33].

## Treatment

There has so far been no proof from randomized controlled trials to prescribe any particular anti-nCoV treatment, and COVID-19 management has been widely supportive [14].

Gautretab et al. studied 20 cases and found a significant decline in the viral carriage and the average carrying duration compared to untreated patients by receiving 600 mg of hydroxychloroquine per day. Furthermore, adding azithromycin to hydroxychloroquine was substantially more effective in virus removal [35].

The convalescent plasma (CP) has been introduced as the primary treatment [36]. The CP is acquired from a person recovered from

COVID-19 by producing humoral immunity against the 2019-nCoV [37]. The preventive and therapeutic advantage of CP is related to the potential source of particular antibodies of human origin [38]. Nevertheless, it is still hard to determine the effectiveness of CP treatment due to the lack of high-quality randomized clinical trial studies and the specific action process of plasma treatment [39].

At this time, the strategy towards COVID-19 is to control the infection source by preventing the infection and controlling measures to minimize the transmission risk, and to provide early detection, quarantining, and assistance to infected patients [18]. Several clinical studies are being conducted to evaluate interventions that are potentially more efficient [21].

**Vaccines**

Vaccination may be the most reliable and cost-effective way to prevent and monitor COVID-19 under the worldwide spread of 2019-nCoV. The extensive studies are now being conducted to promote the production of vaccines against 2019-nCoV. In particular, the 2019-nCoV S protein remains a primary goal for vaccine production [39].

**The huge expression of ACE-2 receptor of COVID-19 on the epithelial cells of the oral mucosa**

A study conducted in 2020 by Xu et al. and the findings showed that the ACE-2 was expressing on oral cavity mucosa and the receptor had been heavily enriched in tongue epithelial cells. Such results clarified the main reason that there is a potentially huge COVID-19 infectious vulnerability risk for oral cavity and brought up a proof for the future prevention procedure in dental practice and daily life. [15]

**The impact of the COVID-19 outbreak on dental services**

In 2020, a study was conducted by Huaqiu Guo et al. [40] on 2537 dental patients. This research found that at the beginning of the COVID-19 outbreak, 38% fewer patients visited the dental offices. The findings highly recommend that COVID-19 greatly impacted dental patients' behavior and the distribution of dental disorders has drastically been altered. The proportion of dental and oral infections increased from 51.0% before the COVID-19 outbreak to 71.9% during COVID-19. The most frequent causes for patients' visits to the emergency room are dental pulpal or periapical lesions, and cellulitis or abscess. By reducing social activities, dental injury reduced from 14.2% to 10.5%. In the meantime, the non-urgency patients decreased by 70% compared to before COVID-19 outbreak. Thus, there is evidence to believe that in the post-COVID-19 era, people's demands for dental services may extremely rise.

**Patient management and prevention of infection**

The American Dental Association proposed on March 16, 2020, that dentists defer all elective procedures and offer just the dental emergency treatment. [41]

1- Tele-screening

Primary telephone screening to recognize suspected patients or probable COVID-19 infection can be remotely done during scheduling appointments. Questions related to primary telephone screening could be any travel history to COVID-19 infected regions and the existence of febrile respiratory illness (FRI) symptoms such as cough and fever. A positive answer to any of these two questions would increase the initial concern and postpone the elective dental care for at least two weeks [42].

2- Patient assessment and care protocol

- Patients should fill out a comprehensive medical history form, a questionnaire of COVID-19 screening, and evaluation of a true emergency questionnaire.
- Dental practitioners should evaluate the body temperature of a patient via a non-contact forehead thermometer or cameras with infrared temperature sensors. Elective dental treatments for patients with a fever over 100.4°F (or 38 °C) and/or signs of respiratory disease should be postponed for at least 2–3 weeks.
- Individuals with suspected COVID-19 infection will be seated in a distinct, well-ventilated waiting room at least 6 feet away from patients receiving treatment who are not infected based on the guidelines of the Centers for Disease Control and Prevention (CDC).
- Patients should wear a surgical mask and practice appropriate respiratory hygiene, for example, use a tissue to cover their mouth and nose when coughing or sneezing, and then throw the tissue away.
- Apply 70% ethanol to clean and disinfect the medical kits (blood pressure cuffs, thermometers, etc.).
- Advise the patients to do self-quarantining and inform their physician to avoid the COVID-19 risk. [1,42]

3- Pharmacologic treatment

An option is a pharmacologic treatment by antibiotics and/or analgesics for suspected or confirmed COVID-19 cases who need immediate dental treatments for conditions such as swelling and/or tooth pain. This method may provide the relief of symptoms and give dental practitioners some time to come up with a plan to perform dental care to minimize the infection spread. The British Medical Journal prescribed acetaminophen as analgesia instead of ibuprofen for COVID-19 infected patients because ibuprofen can interfere with the immune system function [42].

4- Dental treatment guidelines

Some cases such as progressive fascial space infection or dentoalveolar trauma would certainly require emergency dental treatment. For suspected or confirmed COVID-19 cases, dental professionals should consider the following guideline: [1,42-44]

- **Hand hygiene**

People are now more aware of handwashing importance to prevent acute respiratory infections. According to WHO, hand hygiene involves either cleaning hands with an Alcohol-Based Hand Rub (ABHR) or water and soap; both have the same efficiency. If the hands are visibly soiled with dirt, blood, and/or body fluids, water and soap should be used; otherwise, ABHRs are recommended. Before touching a patient and any cleaning or aseptic action, and after having contact with body fluid, touching a patient, and touching the surroundings of a patient, hand hygiene should be done.

- **Personal protective equipment (PPE)**

During dental procedures, the spread of oral microorganisms mainly moves towards the face of the dentist, especially in eyes and all around the nose, which are critical parts for the transmission of infections. PPE may create an efficient block against most potential dangers of aerosols produced from the operative area.

1. Protective glasses and face shields: There is clinical proof that since infectious droplets could readily attack the epithelium of human conjunctival, COVID-19 can be transferred by contact with the mucous membranes lining the eyes. Therefore, protective glasses or face shield should be used during the treatment to cover the eyes from aerosols and debris produced throughout dental treatment and they also should be disinfected between patients' visits.

2. Face masks: A medical mask (surgical or procedure mask) should be worn while operating at a distance of less than 1 m from the patient.

A particulate respirator that is at least as secure as a National Institute for Occupational Safety and Health-certified N95, European Standard Filtering Face Piece 2 (EU FFP2), or equivalent, was used when running aerosol generation methods. When performing emergency dental treatment with suspected COVID-19 cases, a higher level of respiratory protection should be considered, such as EU FFP3 respirators conforming to European Standard 149 (EN149). A higher level of respiratory safety such as EU FFP3 respirators comply with European Standard 149 (EN 149) is required if the patient is a suspected or confirmed COVID-19 during emergency dental treatment.

- **Pre-procedural mouthrinse**

One of the most efficient ways to decrease the proportion of microorganisms in oral aerosols is pre-procedural mouthrinse. According to a *meta*-analysis by Marui, pre-procedural mouthrinse including chlorhexidine (CHX), cetylpyridinium chloride (CPC), and essential oils led to a mean reduction of 68.4% colony-forming units (CFU) in dental aerosols. Although the pre-procedural mouthrinse impact on coronavirus is still uncertain, CHX is efficient against some infectious viruses such as human immunodeficiency virus (HIV), herpes simplex virus (HSV), and hepatitis B virus (HBV). (Wood and Payne, 1998)

Approximately 0.12% CHX has been used as pre-procedural mouthrinse. If a patient experiences any other side effects such as tongue stain or mucosal irritation, 0.05% CPC can be a suitable option.

- **Radiographs**

Extra-oral imaging such as panoramic radiograph or cone-beam computed tomography (CBCT) should be used to prevent the cough or gag reflex that happened during intraoral imaging. When intraoral imaging is required, sensors should be double-covered to avoid cross-contamination and perforation.

- **Rubber dam**

Using a rubber dam reduces splatter production. Rubber dam must be used during endodontic treatment and in pediatric and restorative dentistry when rotary instrumentation is needed. Also, using rubber dam during fixed partial denture or single-crown preparation should be taken into consideration. For instance, prepare a supra-gingival margin for the posterior bridge or apply a split dam technique. Additionally, it can be beneficial to locate the rubber dam to cover the nose and reduce the transmission of COVID-19.

- **Single-use tools**

Dentists should apply single-use devices for example syringes, mouth mirror, and blood pressure cuff to avoid cross-contamination.

- **Reduce aerosol production**

Effective treatment should decrease the aerosol generation. Ultrasonic instruments, for instance, can place a higher risk of producing contaminated aerosols. Since hand and ultrasonic instrumentation are both equally successful in eliminating plaque and calculus, it is suggested to manually scale and polish them. Furthermore, the use of high-speed handpieces and three-way syringes should be minimized by dentists during the COVID-19 outbreak.

Dentists should minimize utilizing rotary instruments when preparing a cavity and in selective patients, they should try using atraumatic restorative procedures or chemomechanical caries removal.

- **Disinfection of the surface**

Human coronavirus may live up to 9 days at room temperature on an inert surface with a higher preference for humid situations. Clinical staff should also check to disinfect inert surfaces using chemicals confirmed against COVID-19 and keep a dry atmosphere to mitigate the 2019-nCoV spread. Such surface sanitizers include 62–71% ethanol, 0.5% hydrogen peroxide, and 0.1% (1 g/L) sodium hypochlorite. After each patient's visit, surfaces should be thoroughly wiped down, particularly around the operating sites.

- **Medical waste disposal**

The medical waste containing disposable protective equipment after use should be promptly delivered to the temporary storage facility of the medical center. The reusable tools and materials should be cleansed, sterilized, and carefully preserved in compliance with the Protocol for the Disinfection and Sterilization of Dental Instrument. The medical and domestic waste produced by treating suspected or confirmed COVID-19 cases are considered to be infectious medical waste. Double-layer yellow clinical waste bags with a "gooseneck" knot should be used. The surface area of the waste bags should be labeled and disposed in compliance with the requirements of medical waste disposal. [13]

- **Other clinical tips**

1- In the case of tooth extraction, do the procedure in a supine position to prevent from operating in the patient's respiratory tract.
2- During removable partial or complete denture try-in, stop touching other items in the dental workplace after contacting the saliva of the patient.
3- All prosthodontics material such as bite registration and whatever removed from the patient's mouth (e.g., dental prosthesis, impressions, etc.) should be completely disinfected by an intermediate-level disinfectant.
4- Salivary suction should be carefully carried out to prevent gag reflex.
5- Choose and modify trays to have the proper size for doing the impression to prevent coughing. Using oral mucosa anesthesia to the throat before performing the impression is a good option for extremely sensitive patients [28].

## Declaration of Competing Interest

The authors declared that there is no conflict of interest.

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